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Kern et al.

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(54) **TRANSLATING DOOR WITH DISENGAGEABLE SEALS**

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(52) **U.S. Cl.** **49/231**; 49/226; 49/370

(58) **Field of Search** 49/125, 226, 227, 49/228, 231, 475.1, 498.1, 483.1, 366, 370, 9; 160/192, 202, 211, 216

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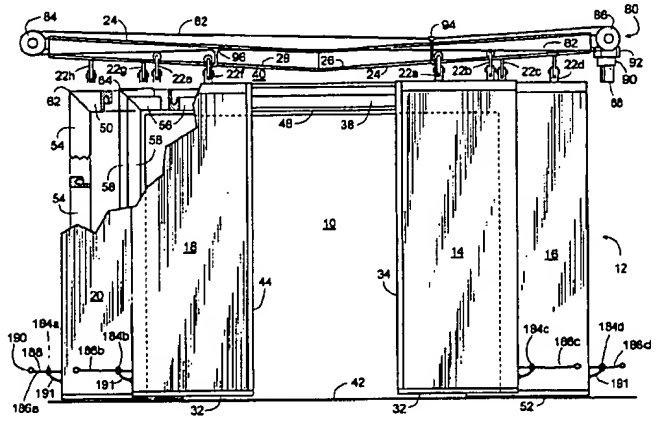
(57) **ABSTRACT**

A generally horizontally sliding door includes a sliding or otherwise translating door panel with a full-perimeter seal that engages sealing surfaces upon closing and at least partially disengages the surfaces upon opening. The door panel travels along an overhead track that is slightly inclined to lower the panel's upper and lower edge seals into engagement with sealing surfaces as the door closes. To provide a substantially full-perimeter seal, a leading edge seal and a trailing edge seal engage sealing surfaces as well. Some of the edge seals are joined to create corner seals. The seals are adapted for single panel sliding doors, bi-parting doors, multi-panel doors, and various combinations thereof.

13 Claims, 9 Drawing Sheets



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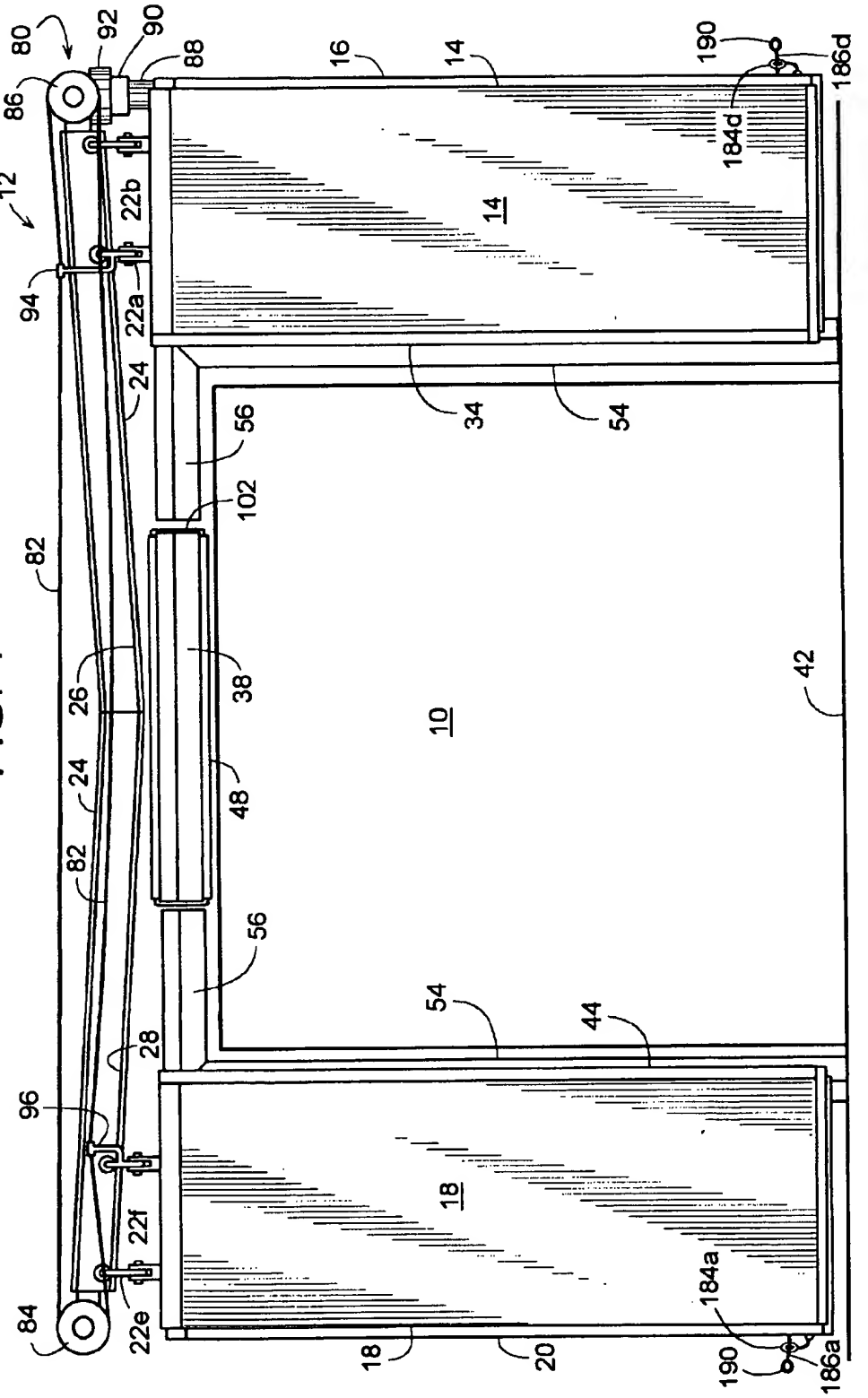
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FIG. 1

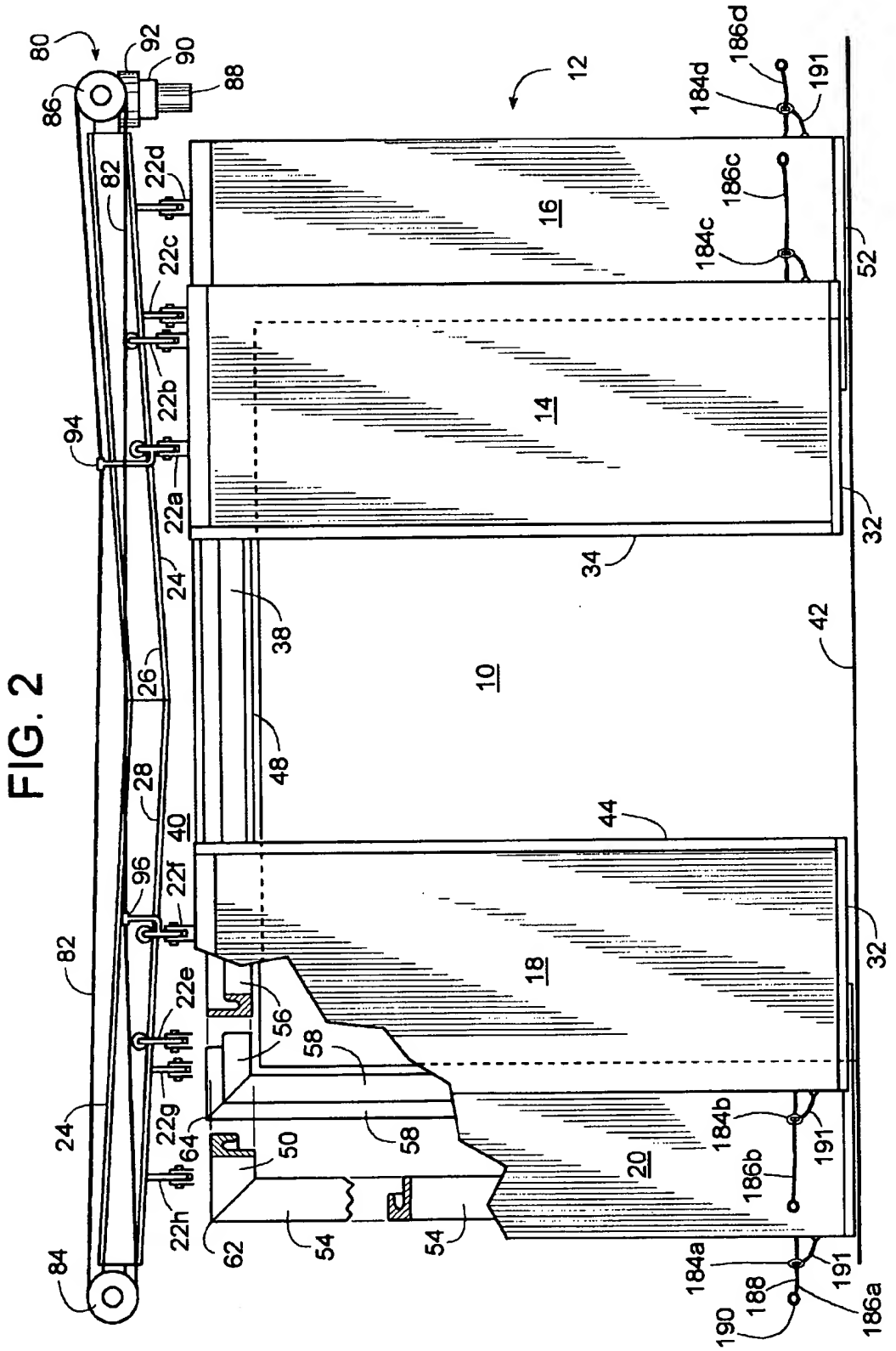
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FIG. 2

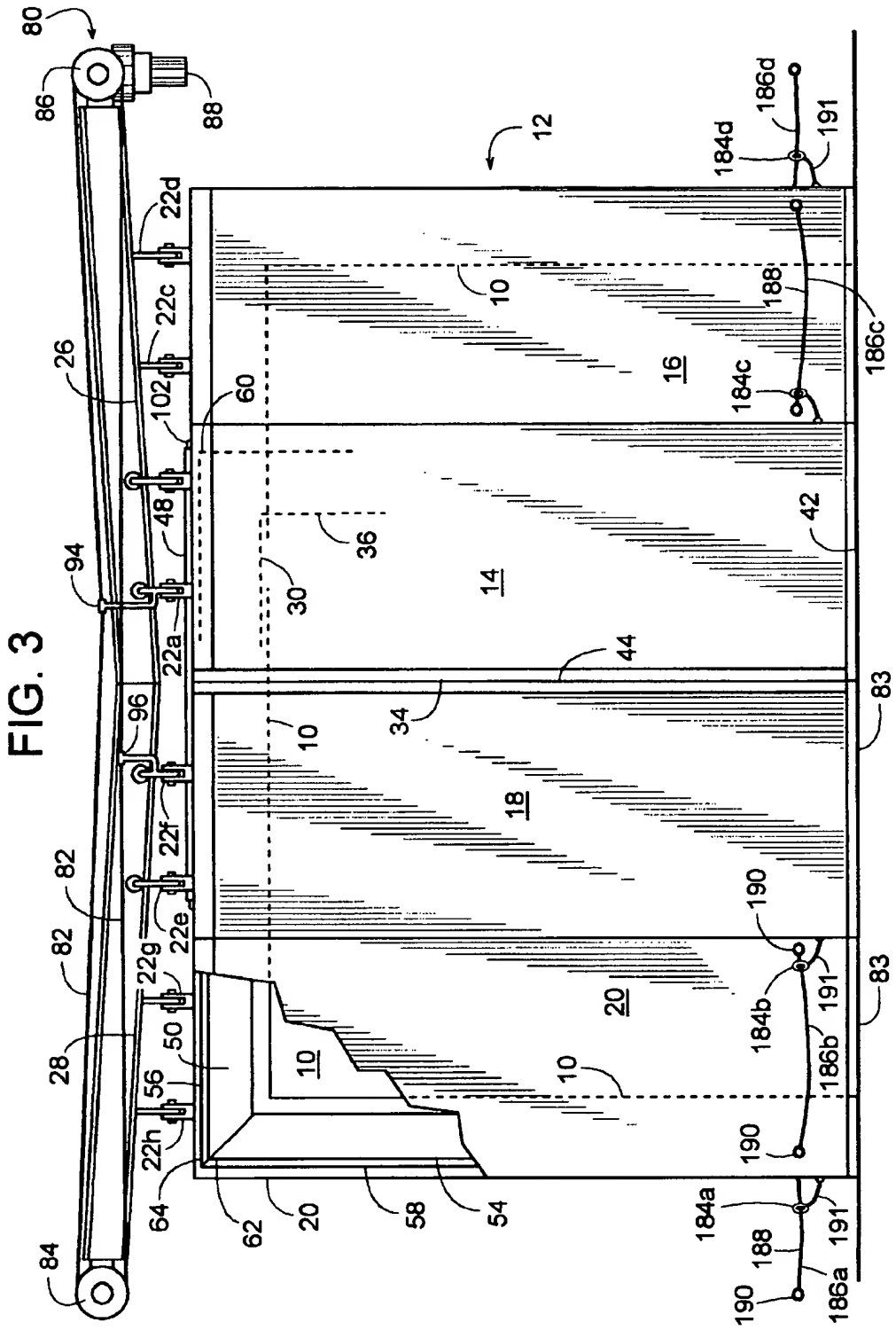
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FIG. 3

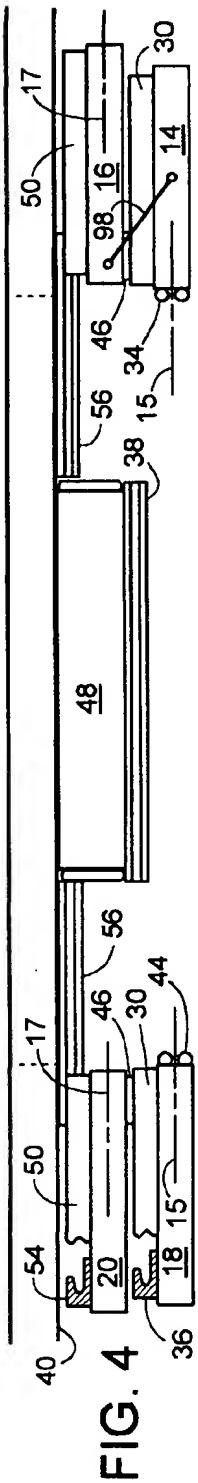

FIG. 4

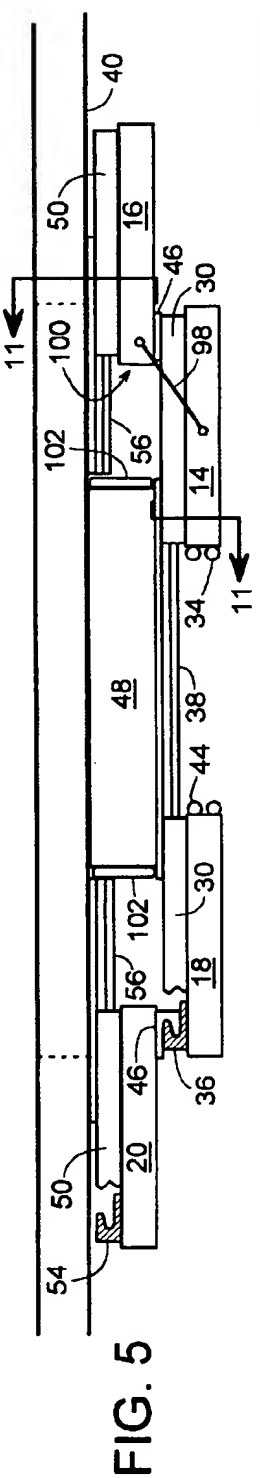

FIG. 5

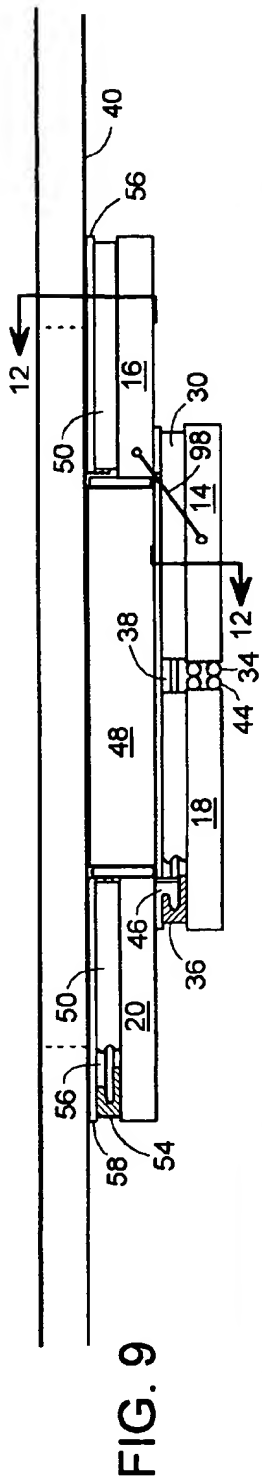

FIG. 9

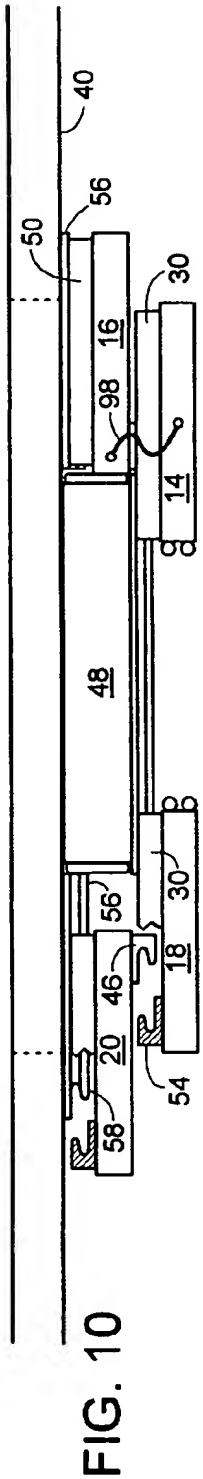

FIG. 10

FIG. 6

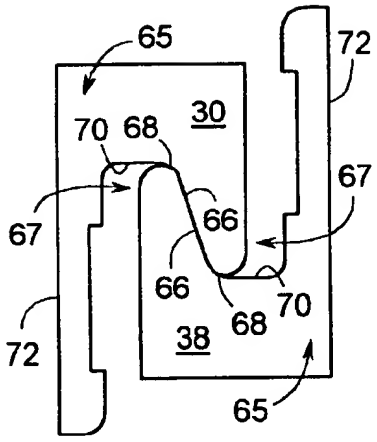

FIG. 7

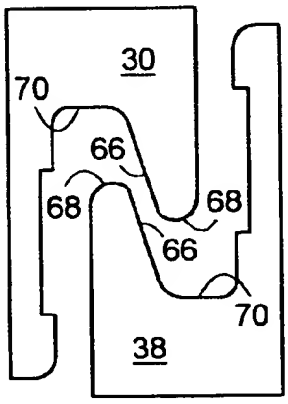

FIG. 8

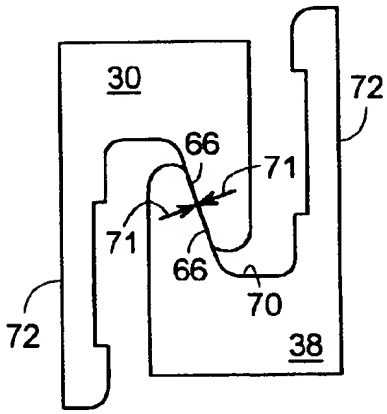

FIG. 11

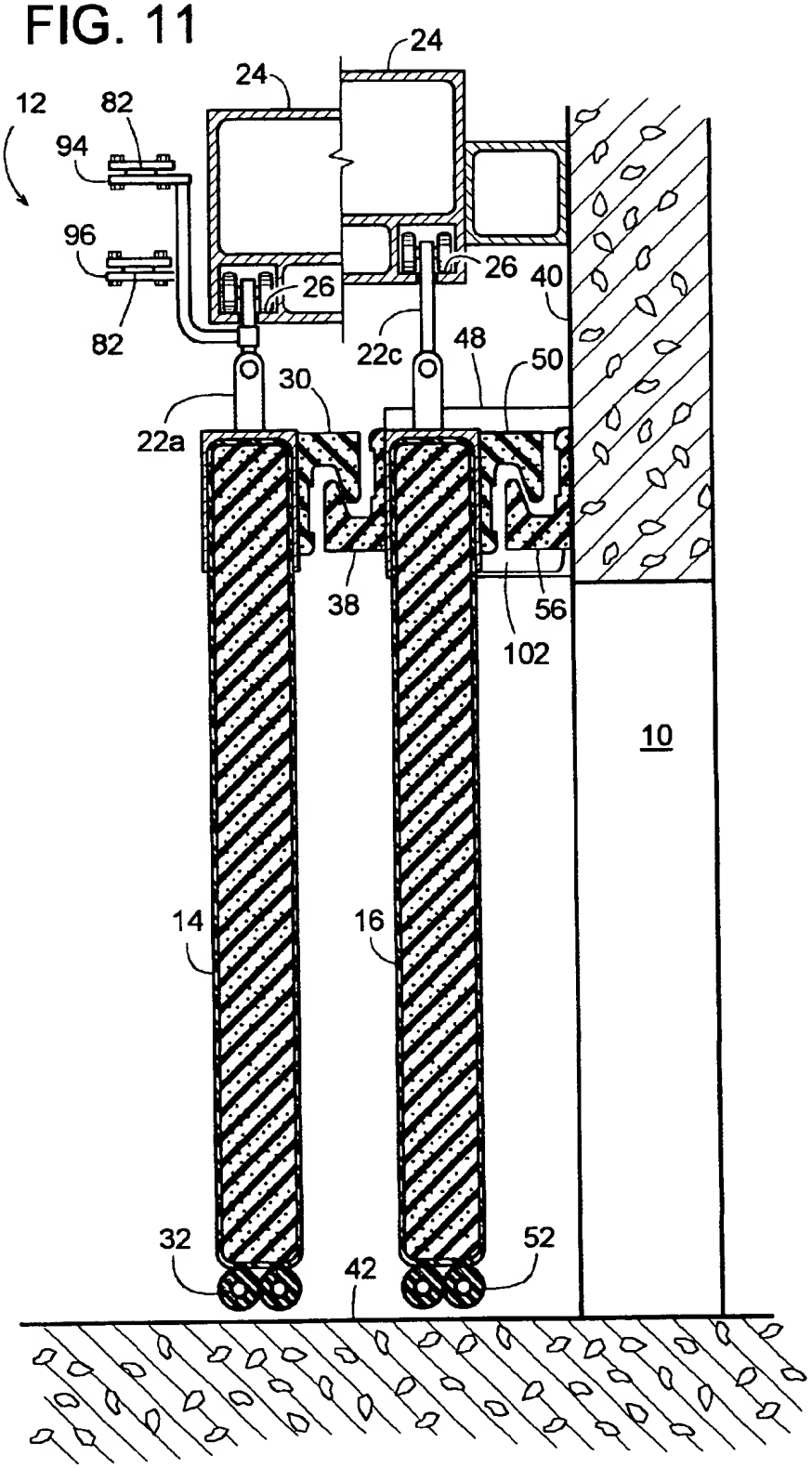
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FIG. 12

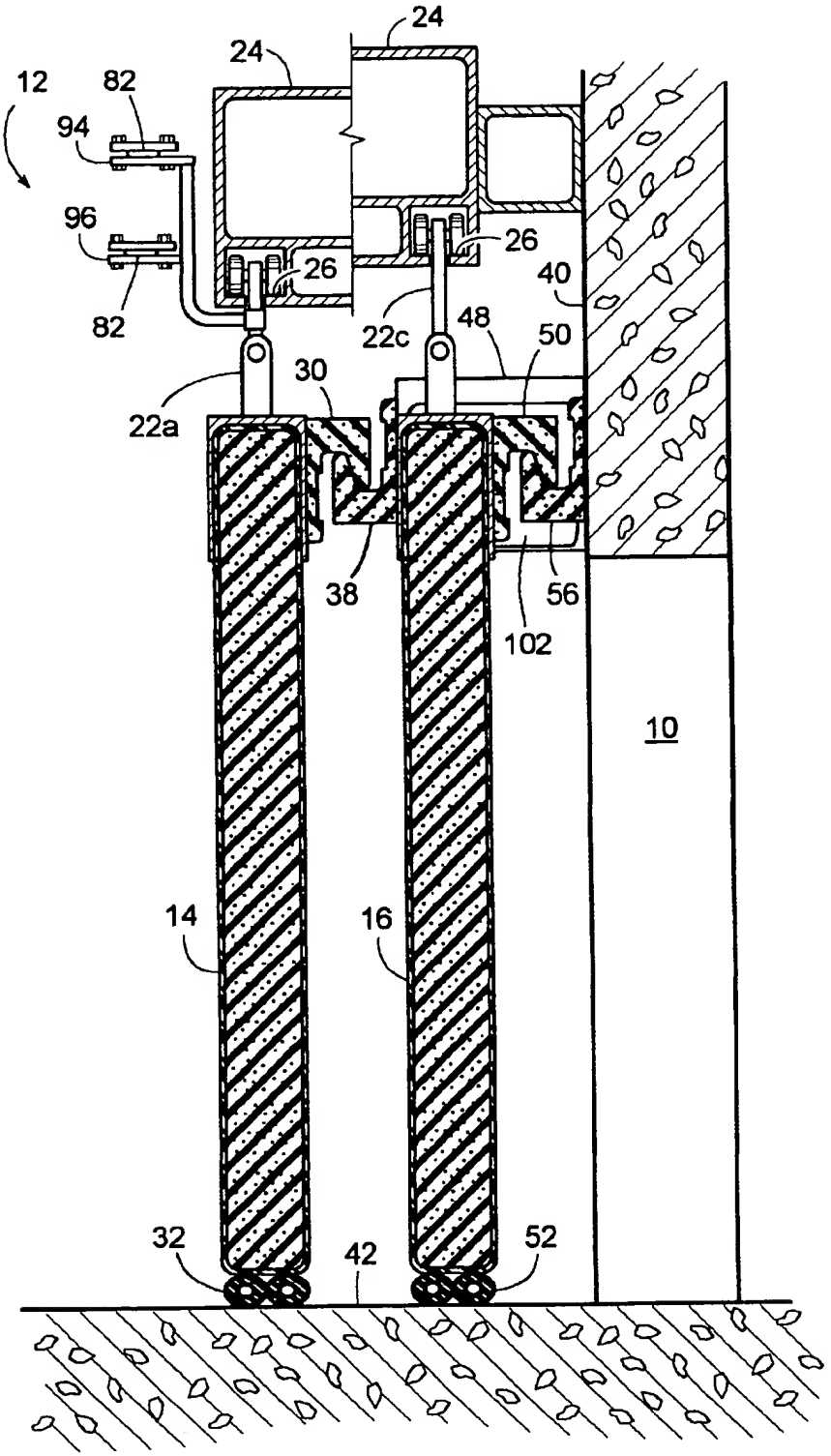
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FIG. 13

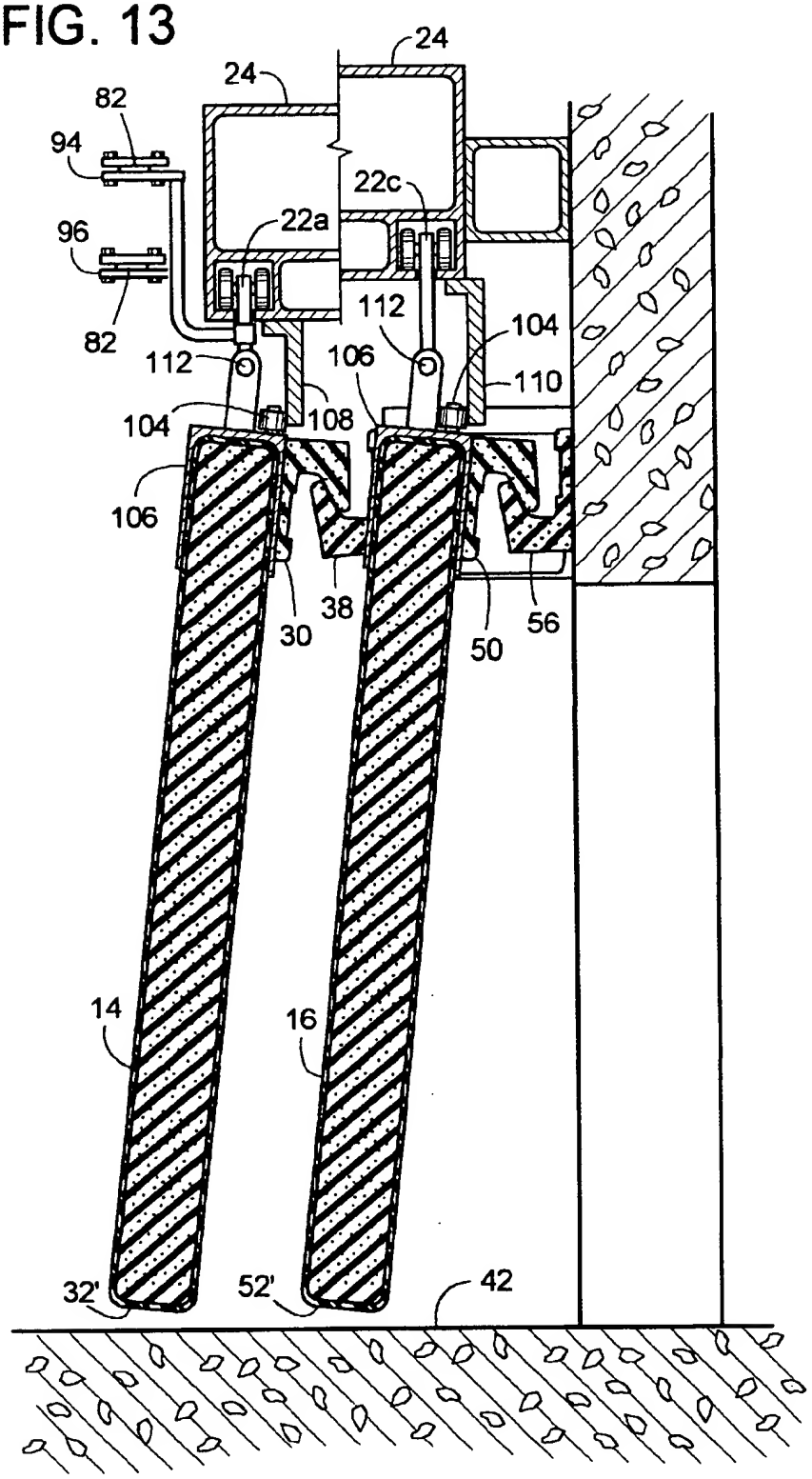
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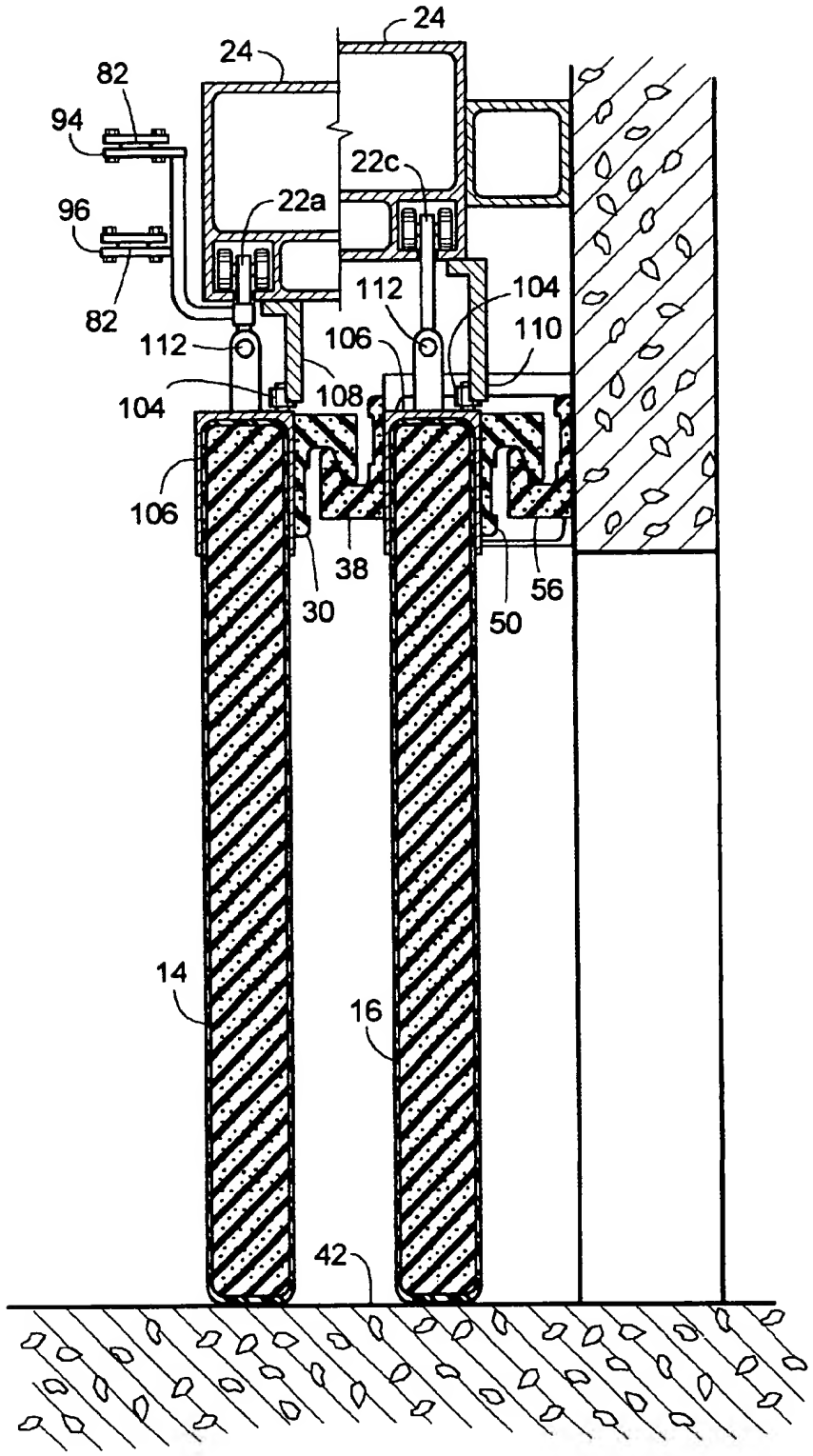
FIG. 14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TRANSLATING DOOR WITH DISENGAGEABLE SEALS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The subject invention generally pertains to what is known as a horizontally sliding door and more specifically to a seal for such a door.

2. Description of Related Art

So-called horizontally sliding doors (which actually may slide or roll) usually include one or more door panels that are suspended by carriages that travel along an overhead track. The carriages allow the door panels to slide or roll in a generally horizontal direction in front of a doorway to open and close the door. The movement of the panels can be powered or manually operated. Depending on the width of the doorway and the space along either side of it, a sliding door can assume a variety of configurations.

For a relatively narrow doorway with adequate space alongside to receive an opening door panel, a single door panel is enough to cover the doorway. Wider doorways with limited side space may require a bi-parting sliding door that includes at least two panels each moving in opposite directions from either side of the doorway and meeting at the center of the doorway to close the door. For even wider doorways or those with even less side space, multi-panel sliding doors can be used. Multi-panel doors have at least two parallel door panels that overlay each other at one side of the doorway when the door is open. To close the door, one panel slides out from behind the other as both panels move in front of the doorway to cover a span of about twice the width of a single panel. Applying such an arrangement to both sides of the doorway provides a bi-parting door with multiple panels on each side.

Although sliding doors are used in a wide variety of applications, they are often used to provide access to cold-storage lockers, which are rooms that provide large-scale refrigerated storage for the food industry. Doorways into such a room are often rather wide to allow forklift trucks to quickly move large quantities of products in and out of the room. The sliding doors are usually power actuated for minimizing the time in which the door is open for the forklift, thus minimizing the amount of cool air that can escape when the door is open. To further minimize the cooling load of the room, the door panels should be thermally insulated and completely sealed around their entire perimeter.

However a tightly sealed door can create frictional drag against mating sealing surfaces as the door opens and closes. Frictional drag can slow the operation of the door and can also create abrasive wear on the sealing surfaces. Unfortunately, increasing the hardness and wear resistance of the seal typically reduces its ability to flex and conform to its mating sealing surface, thus reducing its ability to seal. On the other hand, making a seal relatively soft and compliant may improve its ability to seal, but often reduces its wear resistance.

For effective sealing, mating seals need to be properly aligned to each other. This is done by properly aligning the door panels that move the seals into position. Unfortunately, it is not uncommon for a forklift or other vehicles to accidentally crash through a closed door. This obviously dislodges the alignment of the door panels and often disengages the seals in an abnormal direction. Separating seals in this manner often involves extreme deformation of the seals.

If the panels can not be readily realigned or the seals do not recover their original shape after the impact, the seal's ability to seal diminishes.

SUMMARY OF THE INVENTION

In order to effectively seal a sliding door, a door panel is provided with a seal that includes a lip that overlaps a mating seal. The seals are sufficiently rigid to help keep the door panel properly positioned, yet are sufficiently compressible and resilient to provide effective sealing, even after being temporarily deformed by an impact.

In some embodiments, an upper edge seal, a lower edge seal, a leading edge seal and a trailing edge seal are disposed about a perimeter of a sliding door panel and together the seals alternately engage and disengage various sealing surfaces as the door panel respectively closes and opens.

In some embodiments, a corner seal provides a continuous seal at an intersection between an upper edge seal and a trailing edge seal of a door panel.

In some embodiments, a sliding door includes mating seals whose compliance and geometry accommodate their misalignment by providing a compressive force between the seals in a direction outside the plane along which the panel moves. This compressive force may either help properly align the seals, or may be used to enhance the sealing itself.

In some embodiments, a sliding door panel rotates slightly about a generally horizontal axis to pivot a lower edge seal of the panel away from a lower sealing surface as the panel translates from a closed position to an open position.

In some embodiments, a sliding restraint system is included to provide gross positioning/guiding of the panels, and to improve the door's ability to readily recover from an impact.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of a mult-panel, bi-parting sliding door in an open position.

FIG. **2** is a front view of the embodiment of FIG. **1**, but with the door between its fully open and fully closed positions. Part of the left side of the door is cut away to show sectional views of its seals.

FIG. **3** is a front view of the embodiment of FIG. **1**, but with the door in its closed position and part of the left side of the door cut away to show its seals engaged.

FIG. **4** is a top view of the embodiment of FIG. **1** with the door fully open, but with the track and some other details omitted for clarity.

FIG. **5** is a top view similar to that of FIG. **4**, but showing the door partially open and moving to its closed position.

FIG. **6** is an end view of two seals in one position.

FIG. **7** is an end view of the seals of FIG. **6**, but in another position.

FIG. **8** is an end view of the seals of FIG. **6**, but in yet another position.

FIG. **9** is a top view similar to that of FIG. **4**, but showing the door in its closed position.

FIG. **10** is a top view similar to that of FIG. **5**, but with the door moving to its open position.

FIG. **11** is a cross-sectional end view taken along line **11—11** of FIG. **5**.

FIG. **12** is a cross-sectional end view taken along line **12—12** of FIG. **9**.

FIG. 13 is a cross-sectional end view similar to that of FIG. 11, but with a panel-tilting feature.

FIG. 14 is a cross-sectional end view similar to that of FIG. 12, but with the same panel-tilting feature shown in claim 13.

DESCRIPTION OF THE PREFERRED EMBODIMENT

To seal off a doorway 10 leading to a cold storage locker or other area within a building, a laterally-moving door such as sliding door 12 is installed adjacent the doorway, as shown FIGS. 1, 2 and 3 with door 12 being shown in an open position, a partially open position, and a closed position respectively. The terms, "sliding door" and "laterally-moving door" refers to those doors that open and close by virtue of a door panel that moves primarily horizontally in front of a doorway without a significant amount of pivotal motion about a vertical axis. The horizontal movement can be provided by any of a variety of actions including, but not limited to sliding and rolling. Moreover, door 12 does not necessarily have to be associated with a cold storage locker, as it can be used to separate any two areas within a building or used to separate the inside of a building from the outside. Although door 12 will be described with reference to a combination multi-panel, bi-parting door, it should be appreciated by those of ordinary skill in the art that the invention is readily applied to a variety of other sliding doors including, but not limited to multi-panel sliding doors, bi-parting doors, and single-panel sliding doors.

As for the illustrated embodiment, door 12 opens and closes by way of four panels 14, 16, 18 and 20 that are mounted for translation in front of doorway 10. In moving between a doorway blocking position (FIGS. 3 and 9) and an unblocking position (FIGS. 1 and 4), panels 14 and 18 generally sweep across a plane 15, and panels 16 and 20 generally sweep across another plane 17 that is generally parallel and offset to plane 15. The specific structure of the panels and their properties such as rigidity and thermal insulating properties can vary widely depending on the application; however, in this example panels 14, 16, 18 and 20 each include a polyurethane foam core encased within a protective outer skin. The translation is provided by suspending the panels from trolleys 22*a–h* that roll along a track 24 mounted overhead, generally above doorway 10. To close door 12, trolleys 22*a–d* roll along a track surface 26 to move panels 14 and 16 to the left (as viewed in FIGS. 1, 2, 3 and 11), and trolleys 22*e–h* roll along another track surface 28 to move panels 18 and 20 to the right until panels 14 and 18 meet at generally the center of doorway 10. The term, "track surface" refers to any surface that supports and/or guides a translating door panel carrier. Examples of a door panel carrier include, but are not limited to, a sliding carriage and a rolling trolley. In some embodiments, one or more track surfaces can be provided by a single overhead track, and multiple track surfaces can be separated or joined in a collinear or angled relationship with each other. For the embodiment of FIGS. 1–3, track surfaces 26 and 28 are provided by track 24 (an assembly) and decline toward the center of the doorway to provide panels 14, 16, 18 and 20 with some vertical movement as the trolleys travel along the track surfaces. The vertical movement facilitates the engagement of seals when door 12 closes and disengagement when it opens.

To effectively seal door 12 when it is closed in front of doorway 10, each door panel is provided with several seals or sealing surfaces around its general perimeter. Referring to FIGS. 2, 4 and 5, the left-side lead panel 18 includes a first upper edge seal 30, a first lower edge seal 32, a first leading edge seal 44 and a first trailing edge seal 36, which upon panel 18 closing respectively engage a first upper sealing surface 38 coupled to a wall 40, a lower sealing surface 42 (e.g., the floor), a forward sealing surface 34 running along a leading edge of panel 14, and a rear sealing surface 46 disposed adjacent a leading edge of panel 20. The first upper sealing surface 38 is coupled to wall 40 by way of a protruding lintel 48 situated above doorway 10. The left-side lag panel 20 is generally parallel to lead panel 18 and is suspended between it and wall 40. Lag panel 20 includes a second upper edge seal 50, a second lower edge seal 52, rear sealing surface 46, and a second trailing edge seal 54, which upon panel 20 closing respectively engage a second upper sealing surface 56 attached to wall 40, lower sealing surface 42, first trailing edge seal 36 of lead panel 18, and a second rear sealing surface 58 attached to wall 40. A similar sealing arrangement is provided for the right-side panels 18 and 20.

Generally, then, the sealing mechanism for the various edges of the door panels are characterized by a first sealing member carried on the panel itself, such as seals 30, 32, 36, 44, 50, 52 and 54. A second sealing member is disposed relative to the moving panel such that the first sealing member and the second sealing member are in engagement when (and preferably only when) the panel is in its doorway blocking position. The second sealing member may be stationary, such as seals 38, 56, 58 and 42. However, the second sealing member may also be moveable, but arriving at its proper position relative to the first sealing member as the panel carrying the first sealing member gets to its doorway-blocking position. Seal 46 is one example of a moveable second sealing member.

To seal certain corners of the door panels some intersecting seals are joined to create various corner seals. For example first upper edge seal 30 intersecting trailing edge seal 36 creates a first corner seal 60 for lead panel 14 (FIG. 3). Second upper edge seal 50 intersecting second trailing edge seal 54 creates a second corner seal 62 for lag panel 16. Second corner seal 62 sealingly engages a mating third corner seal 64 created by the intersection of second upper sealing surface 56 and second rear sealing surface 58.

For effective sealing even with some seal misalignment in directions both perpendicular and parallel to a door panel, edge seals 30, 36, 50 and 54 and comparable sealing surfaces 38, 46, 56 and 58 are each of a geometry that provides a compressive force between sealing surfaces that is outside the plane of movement of the panel or panels being sealed. The nature of this compressive force will be detailed below. In this embodiment, the compressive force is provided by the seal members being comprised of a somewhat L-shaped or U-shaped unitary piece of neoprene foam with ample compliance and resilience. The specific geometry of a seal or sealing surface can vary; however, an exemplary set of mating seals 30 and 38 are shown in FIGS. 6, 7 and 8.

In this example, seals 30 and 38 each include a lip sealing surface 66 interposed between an attachment end 65 and a distal end 67, with end 65 being adapted to attach to a door panel or be attached in fixed relationship relative to doorway 10. When end 65 is attached to a door panel, lip sealing surface 66 is preferably facing the panel. A lip sealing surface is "facing the panel" when a line normal to the lip sealing surface projects through the plane along which the panel sweeps, such as plane 15 or 17. In some embodiments, lip sealing surface 66 is situated between a tip surface 68 and a recessed surface 70. When seals 30 and 38 are sealingly engaged as shown in FIG. 6, tip surface 68, lip sealing

surface **66** and recessed surface **70** of seal **30** respectively engage recessed surface **70**, lip sealing surface **66** and tip surface **68** of seal **38**. The same surfaces disengage when the seals completely separate as shown in FIG. **7**. In some cases, only sealing surfaces **66** engage while only the tip surfaces **68** and recessed surfaces **70** disengage, as shown in FIG. **8**. Consequently, the terms, "engage" and "disengage" are used in a relative sense, in that seals **30** and **38** engage upon moving from the configurations of FIG. **7** or **8** to that of FIG. **6** or upon moving from the configuration of FIG. **7** to that of FIG. **8** or to any position where there exists at least a line contact between the two. Thus, seals **30** and **38** of FIG. **8** may be engaged or disengaged depending upon their previous configuration (i.e., the configuration of FIG. **6** or **7**). In the case where seal **30** is attached to a first panel and at least partially engages seal **38** when stationary or attached to a second panel, the lip sealing surfaces **66** face each other. And sealing surface **66** of seal **30** positions distal end **67** of seal **38** between attachment end **65** of seal **30** and at least one of the first panel or the attachment end **65** of seal **30**. The same applies to corner seals **60**, **62** and **64** in that they each have facing sealing surfaces **66**, however, the engagement of their sealing surfaces create an L-shaped pattern of contact.

The geometry of the seal members just described provides a compressive force **71** between sealing surfaces that is outside the plane of panel movement. Seal members **30** and **38** includes overlapping lip sealing surfaces **66** with one or both disposed at an angle relative to a mounting surface **72**. In this example, mounting surface **72** is generally parallel to the plane of movement of the panel on which the seal is mounted. Engagement of seals **30** and **38** results in compressive force **71** being directed generally perpendicular to sealing surfaces **66** and at an angle (i.e., between zero and ninety degrees) to the plane of panel movement. Compressive force **71** in conjunction with seal **30** and/or **38** results in energy being stored at lip sealing surfaces **66** to enhance sealing. Moreover, compressive force **71** being at an angle helps draw seal members (or the movable panels to which they may be attached) toward each other in their proper position to ensure that mating seals fully engage each other. Thus, compressive force **71** may enhance sealing and/or assist in proper seal or panel alignment.

The operation of door **12** and its seals is more clearly understood by first referring to the door's open position shown in FIGS. **1** and **4**. From this position, a drive unit **80** moves lead panels **14** and **18** toward the center of doorway **10** to close door **12**. Drive unit **80** can be any of a wide variety of known mechanisms for operating a sliding door. However, in one embodiment, drive unit **80** includes a timing belt **82** disposed about two cogged sheaves **84** and **86**. Sheave **86** is driven by a motor **88** through a gear reduction **90** and a clutch **92**, while sheave **84** serves as an idler. One clamp **94** couples trolley **22***a* of panel **14** to move with an upper portion of belt **82**, and another clamp **96** couples trolley **22***f* of panel **18** to move with a lower portion of belt **82**. Thus, depending on the rotational direction that motor **88** turns sheave **86**, panels **14** and **18** move together to close the door or apart to open it. Sheave **86** turning counter clockwise (as viewed looking into FIG. **3**) moves belt **82** to pull lead panels **14** and **18** toward each other. According to an aspect of the invention, lag panels **16** and **20** are moved to the closed position by virtue of being coupled to the movement of the associated lead panels **14** and **18** respectively. Alternative structure for achieving this is shown in FIG. **5**. In closing the left half of door **12**, lead panel **18** pulls lag panel **20** by way of seal **36** on panel **18** engaging seal **46** on panel **20**. This requires seals **36** and **46** to be formed of material with sufficient rigidity to transfer some of the momentum of lead panel **18** to lag panel **20**, and thus be used to transmit the pulling load necessary to close the door. However, the material of the seals is also preferably soft enough to provide effective sealing. For the right half of door **12**, lag panel **16** also starts moving to a closed position, as shown in FIG. **5**, upon taking up the slack in a link **98** that couples lag panel **16** to lead panel **14**. Link **98** can be any one of a variety of connections that couple the motion of one panel to another. Examples of link **98** include, but are not limited to, a rigid sliding link or an elongated pliable member such as a strap, chain or cable. Alternatively, a more complex linkage and auxiliary drive for the lag panel can be employed, as disclosed in U.S. patent Ser. No. 09/394,789 filed concurrently and herewith incorporated by reference. Although only one link **98** is shown in the drawing figures, another link **98** may be added to connect panel **18** to panel **20** on the left side of door **12**, which would allow lead panel **18** to pull lag panel **20** back to the unblocking position. With link **98** being pulled tight and trailing edge seal **36** engaging rear sealing surface **46** on both the right and left side of door **12**, all four panels **14**, **16**, **18** and **20** are able to move in front of doorway **10** to close door **12**.

As door **12** moves to its closed position, upper edge seals **30** and **50** travel across upper sealing surfaces **38** and **56** respectively, but remain relatively disengaged as shown in FIG. **11** (With track **24** being inclined, an unusual vertical shift appears down the center of track **24** of FIG. **11** due to the cross-sectional view being taken across two different elevations of the track.). Upon reaching the closed position of FIG. **9**, leading edge seal **34** of panel **14** abuts forward sealing surface **44** of panel **18**. And the movement of panels **14**, **16**, **18** and **20** down inclined track surfaces lowers the lower edge seals **32** and **52** onto the floor below doorway **10** and lowers the upper edge seals **30** and **50** into sealing engagement with the upper sealing surfaces **38** and **56**, as shown in FIGS. **9** and **12**. The same occurs on the left side of the door. In this embodiment, leading edge seal **34**, forward sealing surface **44**, and lower edge seals **32** and **52** are resilient, compressible polyurethane foam tubes, however a variety of other known seals are well within the scope of the invention. Since rear sealing surface **46** is spaced apart from the second upper edge seal **50**, a span or gap **100** between the two is sealed by a span seal **102** (FIG. **5**). Span seal **102** can be attached to either end of lintel **48** to engage the leading edges of panels **16** and **20** as shown, or attached to the leading edges of panels **16** and **20** to engage the ends of lintel **48**. As with the other seals, span seal **102** is a compressible, resilient neoprene foam.

To open door **12**, the operation of the door panels and the seals is basically the opposite of closing. Drive unit **80** pulls lead panels **14** and **18** away from the center of doorway **10**, which first slackens link **98** as shown in FIG. **10**. But as panels **14** and **18** continue to open, link **98** eventually retightens to pull lag panels **16** and **20** back out to the open position as shown in FIG. **4**. In the case where lag panel **20** was closed by engagement of its leading edge seal **46**, an alternative means for moving the rear panel may be employed, such as the auxiliary drives from the earlier-mentioned and incorporated U.S. application Ser. No. 09/394,799. The outward horizontal movement of panels **14** and **16** separates seals **34**, **36** and **54** from sealing surfaces **44**, **46** and **58** respectively. And the vertical movement of panels **14** and **16** as they travel along track **24** lifts seals **30**, **32**, **50** and **52** away from sealing surfaces **42**, **38**, **56** and **42** respectively.

To guide the lower edges of the door panels and to prevent a pressure differential across the door from deflecting the

door excessively, each panel is associated with a slide **184***a–d* that slides along a slide restraint **186***a–d*. For the embodiment of FIGS. **1–3**, each slide **184***a–d* is steel ring, and each slide restraint **186***a–d* is an elongated nylon strap **188** threaded through one of the rings and anchored at each end **190** of the strap. To restrain panel **20**, restraint **186***a* is attached to wall **40** with its corresponding slide **184***a* being attached to panel **20**. To restrain panel **18**, restraint **186***b* is attached to lag panel **20** with its corresponding slide **184***b* being attached to lead panel **18**. To restrain panel **14**, restraint **186***c* is attached to lag panel **16** with its corresponding slide **184**c being attached to lead panel **14**. To restrain panel **16**, restraint **186**d is attached to wall **40** with its corresponding slide **184***d* being attached to panel **16**. For this exemplary embodiment, each ring is attached to its appropriate panel by way of a short strap **190**. Although the actual structure of the slides and slide restraints can vary, in some embodiments it is preferable to use a strap and ring design. With such a design, if a vehicle strikes door **12**, the flexibility of strap **188** allows a door panel to yield without breaking either a panel or the slide restraint. And a slide that encircles the strap will remain engaged with its strap even during a collision. Thus after the collision, the door panel, its slide and slide restraint should all automatically return to their normal operating conditions. In some applications, however, it may be desirable to make the slide from a ring or S-hook of marginally adequate strength to serve as a relatively inexpensive "weak link." In the event of a severe collision, the weak link breaking away could prevent damaging something more expensive. It should be noted that an obvious variation to the embodiment just described, would be to attach slides **184***a*, **184***b*, **184***c* and **186***d* to wall **40**, panel **20**, panel **16** and wall **40** respectively, and mount their corresponding slide restraints **186***a*, **186***b*, **186***c* and **186***d* to panel **20**, panel **18**, panel **14** and panel **16** respectively. In other words, just exchange the mounting positions of the slides with those of the slide restraints, and vice versa.

Although the primary benefit of an angled track is reduced wear on the lower seal, the same result can be achieved by tilting the panels away from the floor as the door moves toward the closed position or as it just begins to open. In the embodiment of FIGS. **12** and **13**, for example, a reaction member such as a cam roller **104** is attached to each upper frame **106** of panels **14** and **16**. As trolleys **22***a* and **22***c* travel along track **24**, cam rollers **104** ride over cam surfaces **108** and **110**, which are fixed relative to track **24**. This causes rollers **104** to urge panels **14** and **16** to pivot about a hinge **112** to tilt panels **14** and **16** away from lower sealing surface **42** (e.g., the floor), as shown in FIG. **13**. Once the door is at its closed position, a relieved portion of the cam surfaces **108** and **110** guide rollers **104** to a position that allows panels **14** and **16** to swing back down into engagement with the floor, as shown in FIG. **14**. It should be noted that lower edge seals **32'** and **52'** in this example, are provided simply by a lower edge that is integral to panels **14** and **16**. Also, one of skill in the art will appreciate that the specific structure of upper seals **30**, **50**, **38**, and **56** may need to be modified to take the rotational motion of the panel into account.

Although the invention is described with reference to a preferred embodiment, it should be appreciated by those skilled in the art that various modifications are well within the scope of the invention. Therefore, the scope of the invention is to be determined by reference to the claims that follow.

We claim:

1. A door for at least partially covering a doorway defined by a wall and a lower surface, comprising:

a first door panel adapted to laterally translate along a plane relative to the doorway between a doorway blocking position and an unblocking position;

a first seal including a first sealing surface interposed between a first attachment end and a first distal end with the first attachment end being attached to the first door panel; and

a second seal disposed to allow relative movement between the first seal and the second seal, the second seal including a second sealing surface interposed between a second attachment end and a second distal end, such that the first door panel in the doorway blocking position causes the first sealing surface to face the second sealing surface and positions the second distal end between the first distal end and at least one of the first door panel and the first attachment end, wherein both the first sealing surface and the second sealing surface are tilted relative to the plane.

2. A door for at least partially covering a doorway defined by a wall and a lower surface, comprising:

a first door panel adapted to laterally translate along a plane relative to the doorway between a doorway blocking position and an unblocking position;

a first seal including a first sealing surface interposed between a first attachment end and a first distal end with the first attachment end being attached to the first door panel;

a second seal disposed to allow relative movement between the first seal and the second seal, the second seal including a second sealing surface interposed between a second attachment end and a second distal end, such that the first door panel in the doorway blocking position causes the first sealing surface to face the second sealing surface and positions the second distal end between the first distal end and at least one of the first door panel and the first attachment end, and

a second door panel adapted to laterally translate along a second plane substantially parallel to and offset out of coplanar alignment with the first plane, wherein the second seal is disposed on the second door panel.

3. A door for at least partially covering a doorway defined by a wall and a lower surface, comprising:

a first door panel adapted to laterally translate along a plane relative to the doorway between a doorway blocking position and an unblocking position;

a first seal including a first sealing surface interposed between a first attachment end and a first distal end with the first attachment end being attached to the first door panel;

a second seal disposed to allow relative movement between the first seal and the second seal, the second seal including a second sealing surface interposed between a second attachment end and a second distal end, such that the first door panel in the doorway blocking position causes the first sealing surface to face the second sealing surface and positions the second distal end between the first distal end and at least one of the first door panel and the first attachment end,

a third seal, and

a fourth seal disposed on the first door panel and spaced from the first seal to define a gap therebetween, wherein the first seal is elongated horizontally, the fourth seal is elongated vertically, and the third seal horizontally spans the gap when the first door panel is in the doorway blocking position.

4. The door of claim 3, wherein the third seal is adapted to be substantially fixed relative to the doorway.

5. A door for at least partially covering a doorway defined by a wall and a lower surface, comprising:

a first door panel adapted to laterally translate along a plane relative to the doorway between a doorway blocking position and an unblocking position; and

a slide disposed on an elongated slide restraint to provide relative sliding motion therebetween, wherein the slide and elongated slide restraint are adapted to be spaced above the lower surface and at least one of the slide and the elongated slide restraint is attached to a first lower portion of the first door panel to limit movement of the first lower portion out of the plane.

6. The door of claim 5, further comprising:

a first seal including a first sealing surface interposed between a first attachment end and a first distal end with the first attachment end being attached to the first door panel; and

a second seal disposed to allow relative movement between the first seal and the second seal, the second seal including a second sealing surface interposed between a second attachment end and a second distal end, such that the first door panel in the doorway blocking position causes the first sealing surface to face the second sealing surface and positions the second distal end between the first distal end and at least one of the first door panel and the first attachment end.

7. The door of claim 5, wherein the slide fully encircles the elongated slide restraint.

8. The door of claim 5, wherein the elongated slide restraint is pliable.

9. The door of claim 5, wherein the slide is attached to the first door panel.

10. The door of claim 5, wherein the elongated slide restraint is attached to the first door panel.

11. The door of claim 5, further comprising a second door panel substantially parallel with the first door panel and being displaced out of coplanar alignment therewith, such that the first door panel and the second door panel both move in a first direction to close the door and both move in a second direction to open the door, wherein the slide and the elongated slide restraint couple the first lower portion of the first door panel to a second lower portion of the second door panel to limit an extent to which the second door panel can be displaced out of coplanar alignment with the first door panel, yet still allow the door to open and close.

12. A door moveable between a doorway blocking position and an unblocking position relative to a doorway defined by a wall and a lower surface, comprising:

a first door panel disposed along a plane and adapted to laterally translate relative to the doorway between the doorway blocking position and the unblocking position;

a second door panel adapted to laterally translate relative to the doorway between the doorway blocking position and the unblocking position;

a first seal disposed adjacent a trailing edge of the first door panel;

a second seal disposed adjacent a leading edge of the second door panel and engaging the first seal with the door in the doorway blocking position and spaced from the first seal with the door in the unblocking position, wherein at least one of the first seal and the second seal are sufficiently pliable to effectively seal therebetween, and wherein the first seal and the second seal are of sufficient rigidity to transfer momentum from the first door panel to the second door panel as the door moves from the unblocking position to the doorway blocking position, whereby the first seal engaging the second seal allows the first door panel moving to the doorway blocking position to pull the second door panel to the doorway blocking position.

13. The door of claim 12, wherein the first seal includes a first sealing surface interposed between a first attachment end and a first distal end with the first attachment end being attached to the first door panel, and wherein the second seal includes a second sealing surface interposed between a second attachment end and a second distal end, such that the first door panel in the blocking position causes the first sealing surface to face the second sealing surface and positions the second distal end between the first distal end and at least one of the first door panel and the first attachment end.

* * * * *

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(12) **United States Patent**
Kern et al.

(10) **Patent No.: US 6,352,097 B1**
(45) **Date of Patent: Mar. 5, 2002**

(54) **MULTI-PANEL DOOR WITH AN AUXILIARY DRIVE MECHANISM**

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(73) Assignee: **Rite-Hite Holding Corporation**, Milwaukee, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/394,799**

(22) Filed: **Sep. 10, 1999**

(51) **Int. Cl.**[7] **E05D 15/06**

(52) **U.S. Cl.** **160/197**; 160/118; 160/202; 160/222; 49/102

(58) **Field of Search** 160/117, 118, 160/119, 214, 222, 223, 224, 225, 197, 200, 202; 49/102, 120, 121, 122, 123

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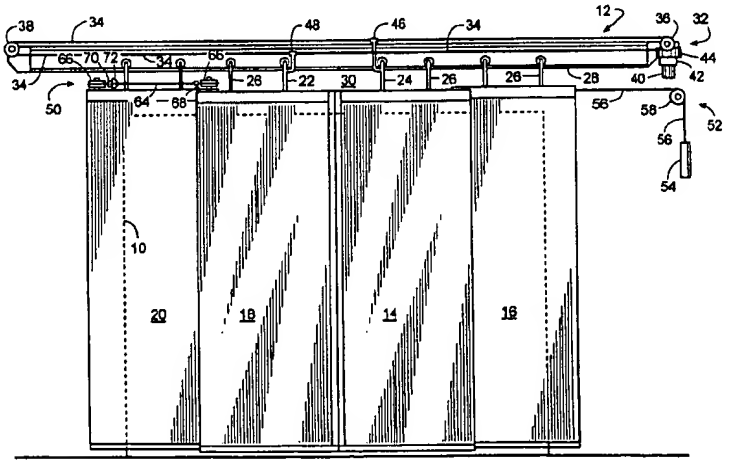
Primary Examiner—Blair M. Johnson
(74) *Attorney, Agent, or Firm*—Marshall, Gerstein, & Borun

(57) **ABSTRACT**

A multi-panel sliding door includes a main drive to directly move a leading door panel and includes an auxiliary drive to smoothly accelerate a lagging door panel. In some embodiments, the auxiliary drive includes a hanging weight that urges the lagging panel to its open position. In another embodiment, the auxiliary drive includes a belt and sheave arrangement attached to the lagging panel. The leading panel is coupled to move the belt around two sheaves as the leading panel moves relative to the lagging one. The belt's movement is limited by a bumper that is attached to one point on the belt and is constrained to travel between one of the sheaves and a fixed stop attached to a wall or the track. As the main drive starts moving the leading panel to its open position, the relative movement between the two panels causes the belt to move the bumper up against the fixed stop. From there, continued opening movement of the leading panel continues rotating the belt around the sheaves. Since the bumper now holds a portion of the belt fixed relative to the stop, the sheaves begin to translate. This begins moving the lagging panel to its open position off to one side of a doorway before the lead panel reaches its open position in front of the lagging panel.

15 Claims, 6 Drawing Sheets



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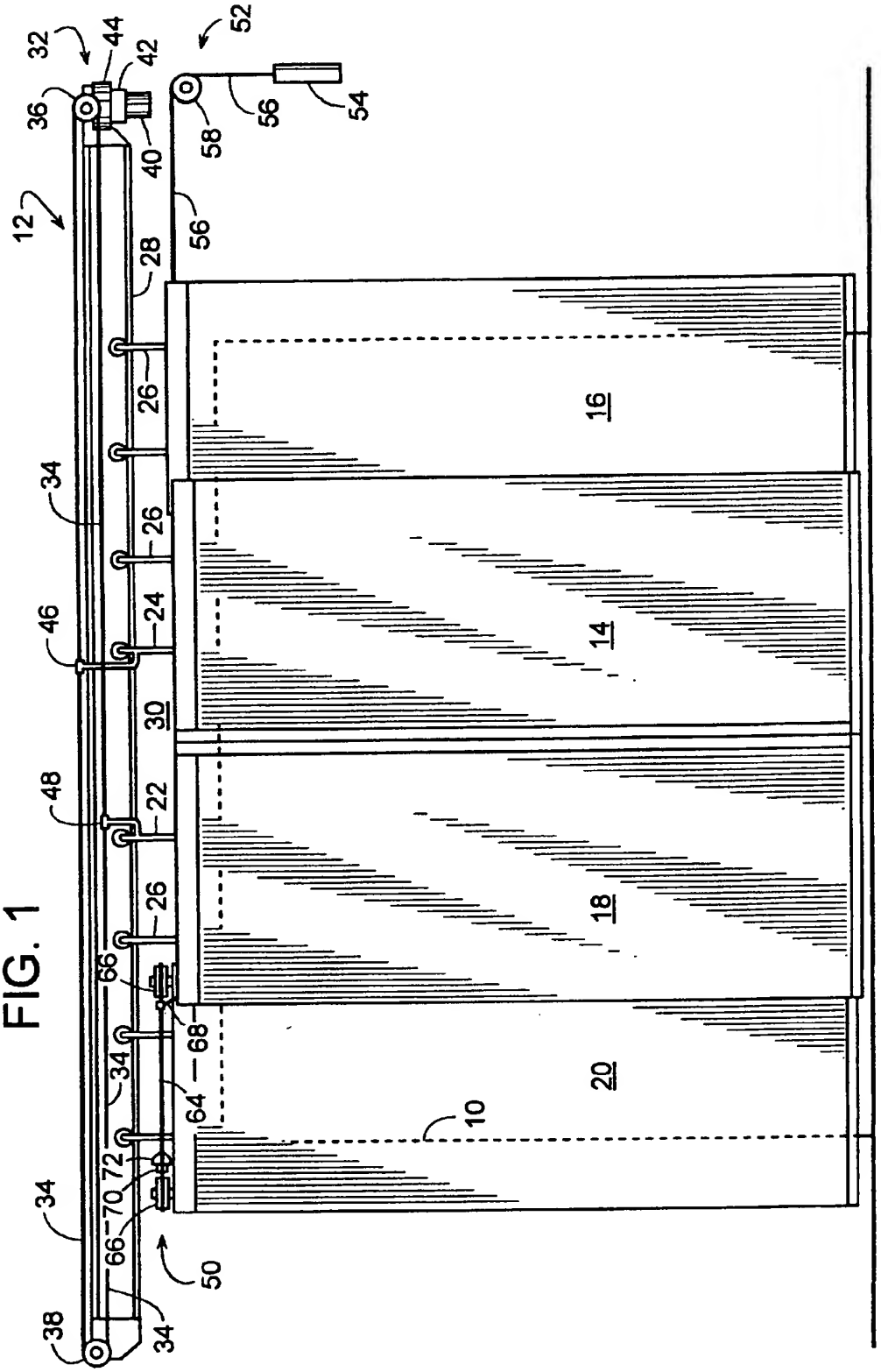
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FIG. 1

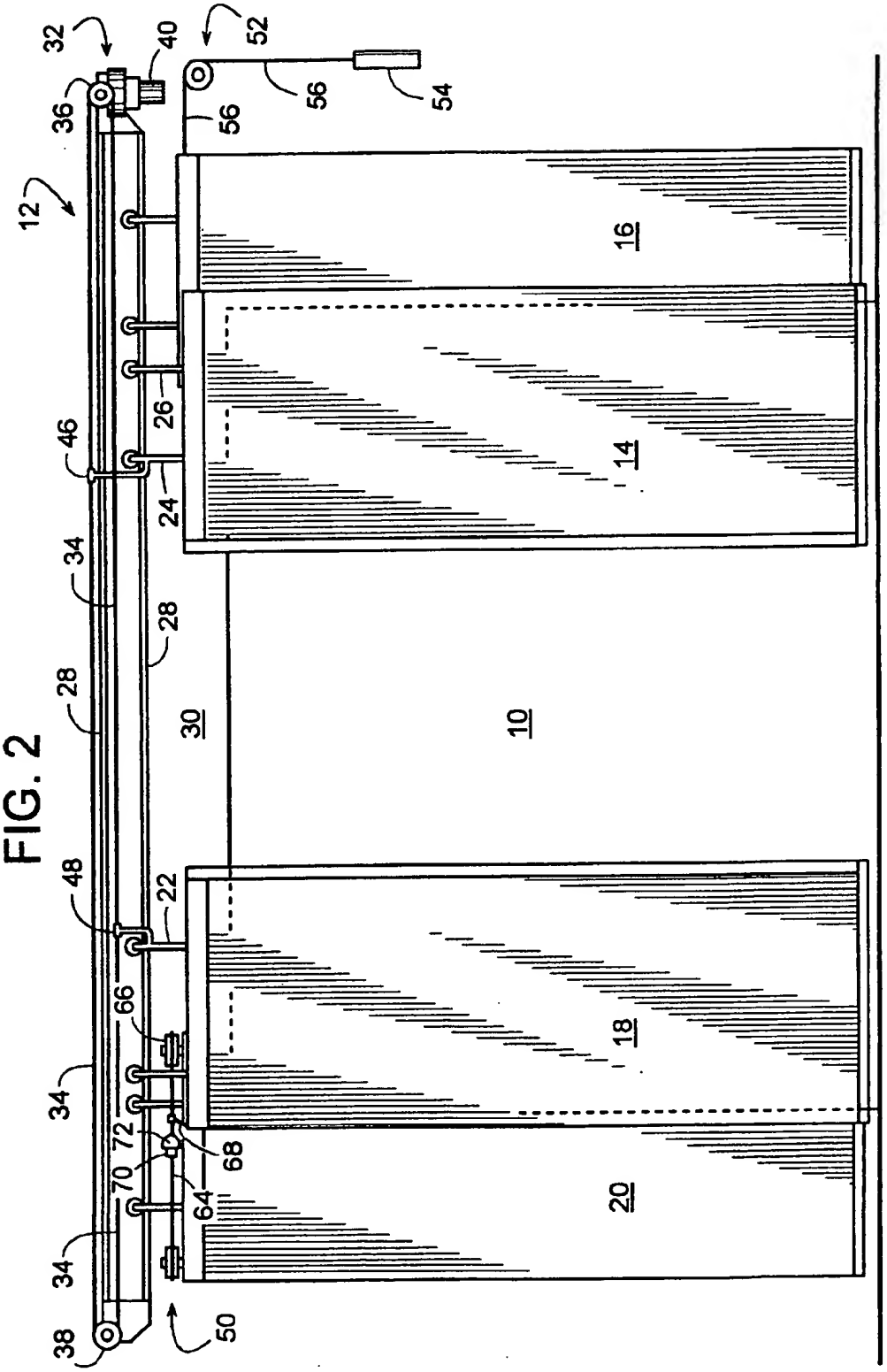
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FIG. 2

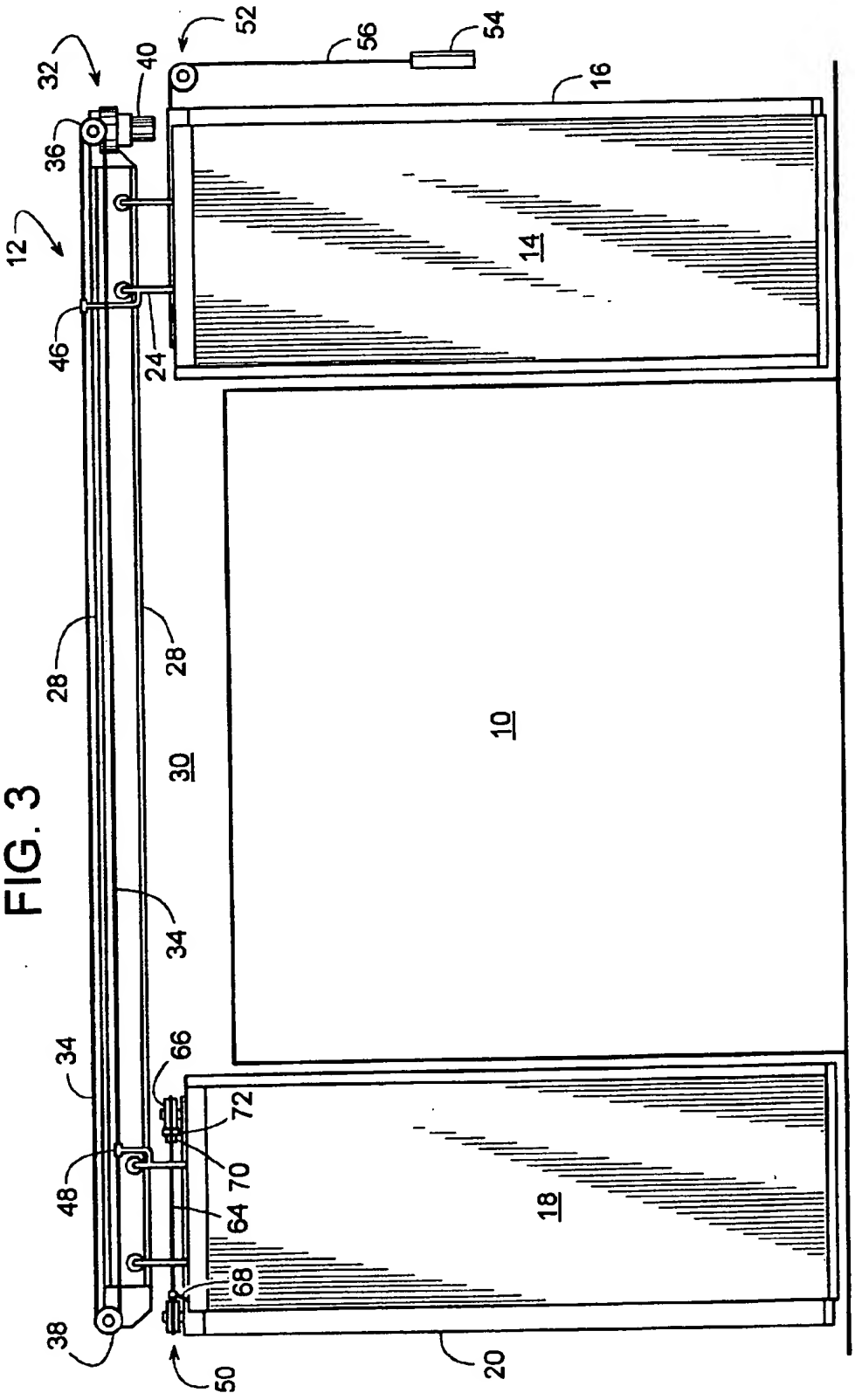
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FIG. 3

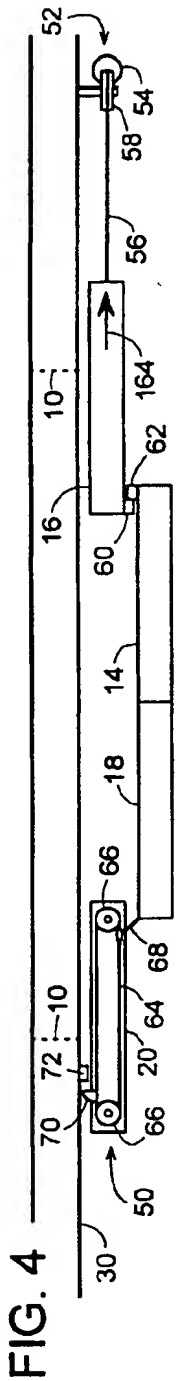


FIG. 4

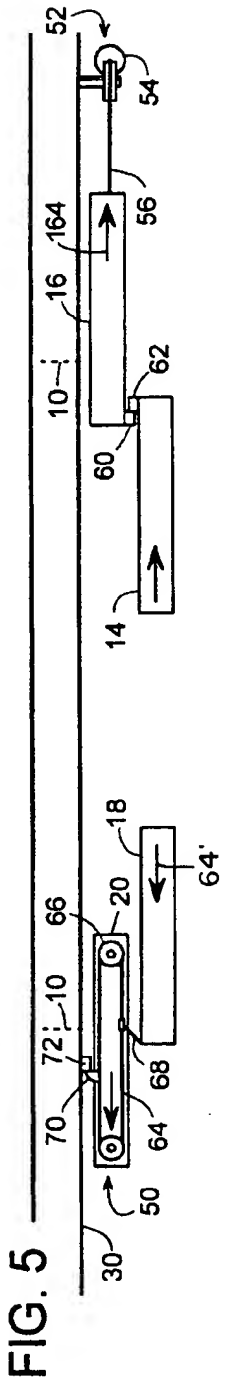


FIG. 5

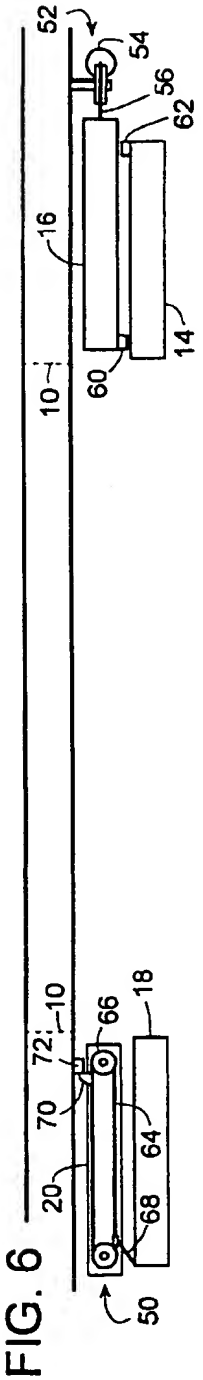


FIG. 6

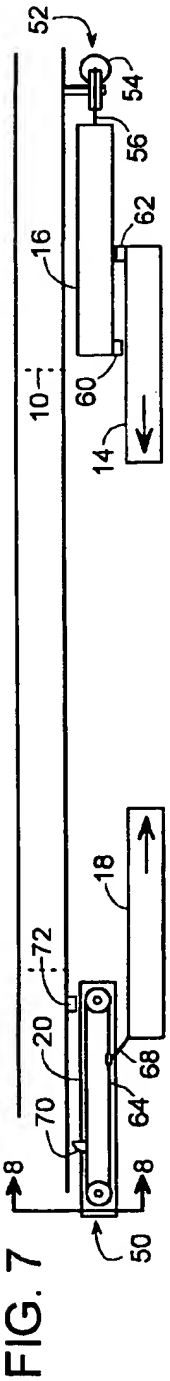


FIG. 7

FIG. 8

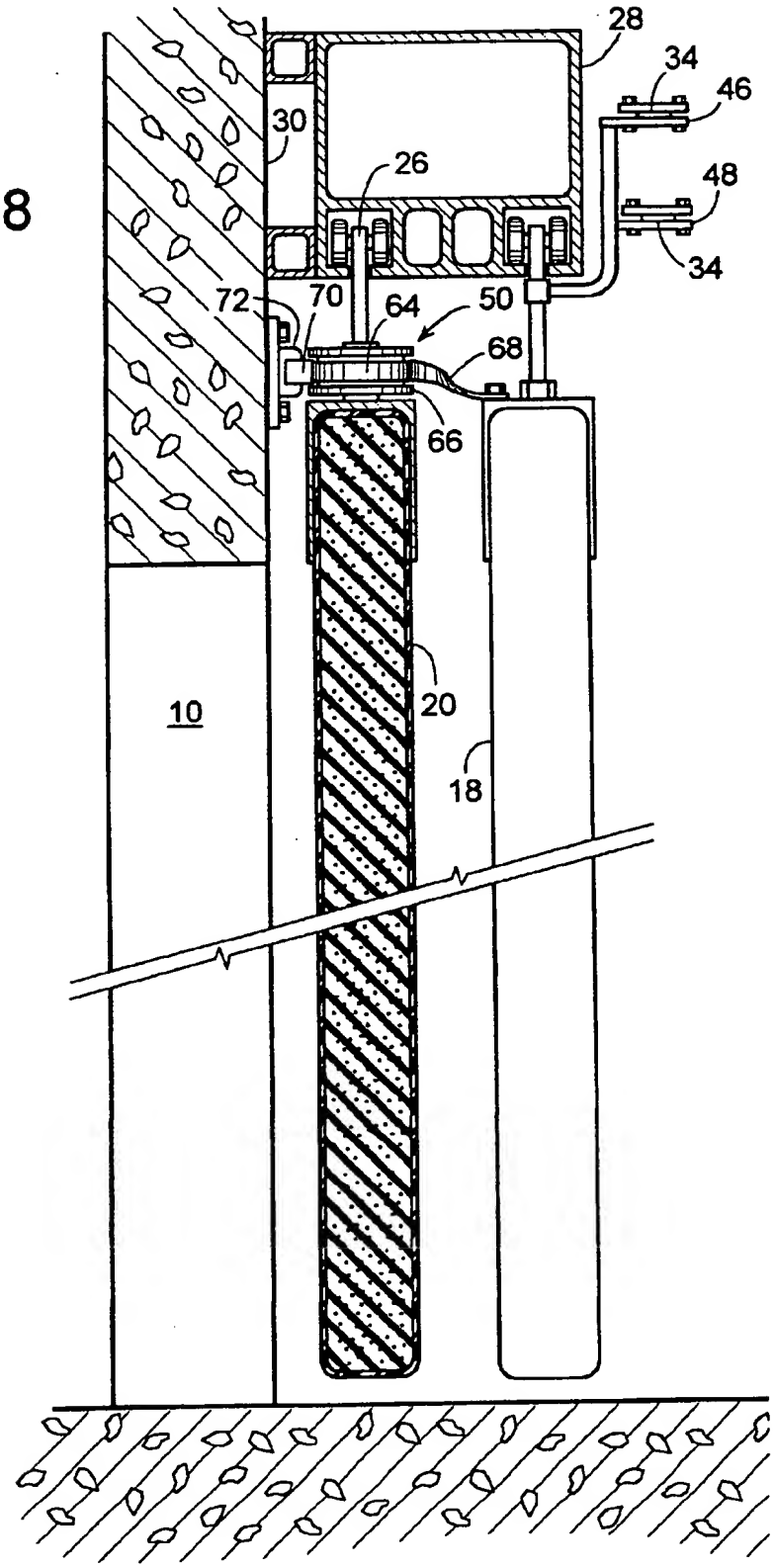


FIG. 9

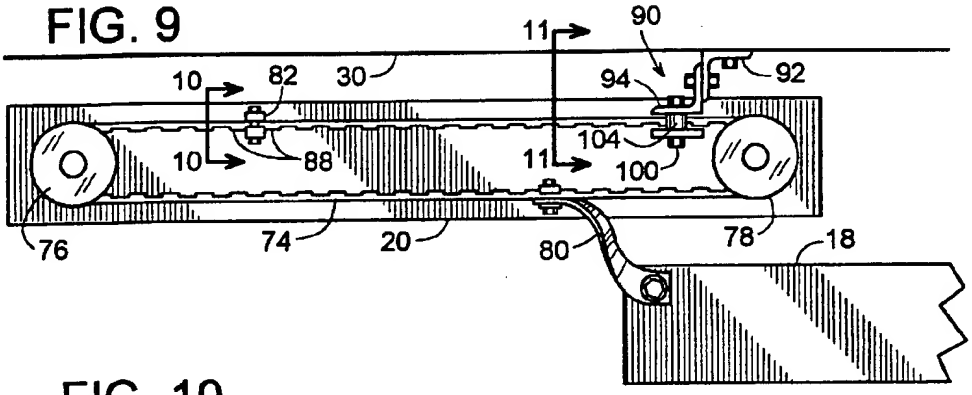


FIG. 10

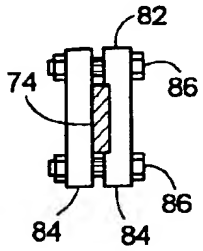


FIG. 11

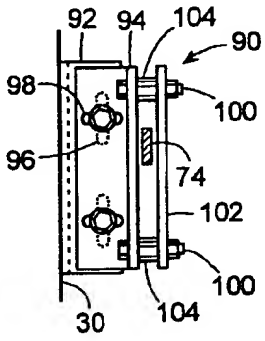
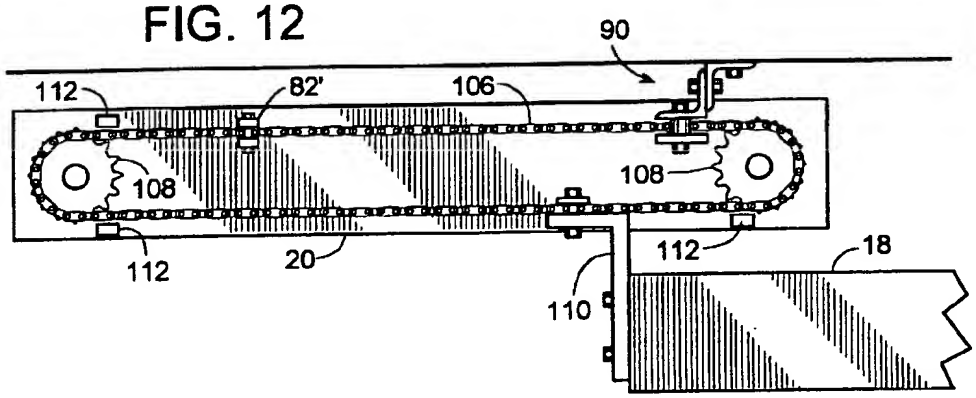


FIG. 12



MULTI-PANEL DOOR WITH AN AUXILIARY DRIVE MECHANISM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The subject invention generally pertains to what is known as a multi-panel sliding door and more specifically to an actuator for such a door.

2. Description of Related Art

So-called multi-panel sliding doors include two or more generally parallel door panels that are suspended by carriages that slide or roll along an overhead track. The carriages allow the door panels to travel in a generally horizontal direction in front of a doorway to open and close the door. When the door is open, the door panels generally overlay each other at one side of the doorway. To close the door, the panels slide out from behind each other to move in front of the doorway. When fully extended, the panels cover a span that approaches the sum of their individual widths. Applying such an arrangement to both sides of the doorway provides a bi-parting door with multiple panels on each side. In which case, leading panels (i.e., those first to pass in front of the doorway) from each side meet at generally the center of the doorway when the door closes.

With multi-panel sliding doors, the horizontal translation of a leading door panel is usually powered by a drive unit, while one or more lagging panels are pulled back and forth into position indirectly by somehow being coupled to the driven movement of the leading panel. To do this, often a vertical edge seal, strap or some other coupling connects a lagging panel to a leading one. As the leading panel is driven to move away from the center of the doorway to open the door, the lagging panel may remain stationary in front of the doorway until the leading panel has moved to where it overlays at least most of the lagging one. At this point the leading panel begins pulling the lagging one along with it to one side of the doorway in response to the coupling engaging or tightening rather suddenly. Due to the inertia of the lagging panel, the sudden action of the coupling creates a reaction comparable to that of an impact between the two panels. A similar mechanism may also be employed to pull the lag panel to the closed position.

The impact-like reaction strains the coupling and the points at which the coupling attaches to the panels. This can damage various components of the door or shorten the door's overall useful life. The impact effect also places a sudden inertial load on the drive unit, which slows the opening of the door.

For doors that are designed to open automatically in the presence of an approaching vehicle, such as a forklift, a slow opening door is susceptible to being struck by a fast moving vehicle. Moreover, a closed door limits a driver's visibility to only what is in front of the door. The nature of the impact can also lead to a jerky, unsmooth door operation, particularly if the lag panel is freely moveable. Moreover, with a free lag panel, it may be difficult to accurately maintain the lag panel in a desired open or closed position, since it may be subject to drift when not directly engaged by or coupled to the lead panel

SUMMARY OF THE INVENTION

To assist in providing smooth door operation and reliable positioning of a lag panel in a multi-panel sliding door, an auxiliary drive is used to move the lag panel.

In some embodiments of a multi-panel sliding door, a primary drive unit moves one panel while an auxiliary drive mechanism that includes a suspended weight moves another panel.

In some embodiments, a primary drive unit moves one panel directly, while moving another panel indirectly by way of an auxiliary drive mechanism that includes a belt, chain or some other flexible ring encircling two rotatable members such as a sheave, sprocket or some other type of wheel, the auxiliary drive being coupled to the driven panel.

In some embodiments, a drive mechanism that includes a belt, chain or some other flexible ring encircling two rotatable members such as a sheave, sprocket or some other type of wheel, also includes a bumper that is attached to the ring and engageable with a stop, wherein the position of the bumper can be varied to allow door panels of a given width to accommodate doorways of different widths.

In some embodiments, a lead and lag panel have a first state where one panel moves independently of the other, and a second state where movement of one panel is dependent on movement of the other panel, with the panels moving at different speeds.

In still other embodiments, lead and lag panels are coupled for movement with a constant speed differential between panels sometime during movement of the panels to an open position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of a mult-panel, bi-parting sliding door in a closed position.

FIG. **2** is a front view of the door of FIG. **1**, but with the door in a partially open position.

FIG. **3** is a front view of the door of FIG. **1**, but with the door open.

FIG. **4** is a schematic top view of FIG. **1**.

FIG. **5** is a schematic top view of FIG. **2** with the door opening.

FIG. **6** is a schematic top view of FIG. **3**.

FIG. **7** is a schematic top view similar to FIG. **5**, but with the door closing.

FIG. **8** is a cross-section view taken along line **8**—**8** of FIG. **7**.

FIG. **9** is a top view of one embodiment of an auxiliary drive mechanism.

FIG. **10** is a cross-sectional view taken along line **10**—**10** of FIG. **9**.

FIG. **11** is a cross-sectional view taken along line **11**—**11** of FIG. **9**.

FIG. **12** is a top view of another embodiment of an auxiliary drive mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

To close off a doorway **10** leading to a room or other area of a building, a laterally-moving door such as sliding door **12** is installed adjacent the doorway, as shown FIGS. **1**, **2** and **3** with door **12** being shown in a closed position, a partially open position, and a fully open position respectively. The terms, "sliding door" and "laterally-moving door" refer to those doors that open and close by virtue of a door panel that moves primarily horizontally in front of a doorway without a significant amount of pivotal motion about a vertical axis. The horizontal movement can be provided by any of a variety of actions including, but not limited to sliding and rolling. Although door **12** will be described with reference to a four-panel, bi-parting door, those of ordinary skill in the art should appreciate that the number of panels could exceed four. There could also be as

few as two, as in the case of a two-panel door that operates from just one side of the doorway.

As for the illustrated embodiment, door **12** opens and closes by way of four panels **14**, **16**, **18** and **20** that are mounted for translation in front of doorway **10**. The specific structure of the panels and their properties such as rigidity and thermal insulating properties can vary widely depending on the application; however, in this example each of the panels include a polyurethane foam core encased within a protective outer skin. Translation of the panels while inhibiting their rotation about a vertical axis is provided, in this example, by suspending each panel from two panel carriers such as sliding carriages or trolleys **22**, **24** and **26** that roll along a track **28**. In some embodiments, track **28** is mounted to a wall **30** and situated overhead and generally above doorway **10**. Track **28** can assume a variety of configurations including, but not limited to, straight and level or slightly angled to create a slope along which the panel carriers move, thereby providing gravity assist to close the door.

To power-operate door **12**, a drive unit **32** moves lead panels **14** and **18** either apart or together to respectively open or close door **12**. Drive unit **32** can be any of a wide variety of known actuators for operating a sliding door. However, in one embodiment, drive unit **32** includes a cogged belt **34** disposed about two cogged sheaves **36** and **38**. Sheave **36** is driven by a motor **40** through a gear reduction **42** and a clutch **44**, while sheave **38** serves as an idler. One clamp **46** couples trolley **24** of panel **14** to move with an upper portion of belt **34**, and another clamp **48** couples trolley **22** of panel **18** to move with a lower portion of belt **34**. Thus, depending on the rotational direction that motor **40** turns sheave **36**, panels **14** and **18** move together to close the door or apart to open it.

To open door **12** from its closed position of FIGS. **1** and **4**, drive unit **32** turns sheave **36** clockwise (as viewed looking into FIG. **1**). This moves belt **34** to pull lead panels **14** and **18** apart from each other and away from the center of the doorway. The outward movement of lead panels **14** and **18** allows their respective lag panels **16** and **20** to move outward as well. An auxiliary drive mechanism **50** on the left-side of door **12** urges lag panel **20** to open to the left, while another auxiliary drive mechanism **52** on the right-side urges lag panel **16** to open to the right. Although both mechanisms **50** and **52** are shown on a single door, they are actually two alternate embodiments, where preferably only one or the other would normally be used on both sides of one door.

As for the right side of the door, to move lag panel **16** to its open position in front of wall **30**, drive mechanism **52** includes a hanging weight **54** that urges panel **16** to the right. Weight **54** applies tension to a cable **56** that is attached to panel **16** and strung over a sheave **58** on wall **30**. The tension in cable **56** pulls a protrusion **60** (FIG. **4**) extending from lag panel **16** up against, or at least towards, a similar protrusion **62** extending from lead panel **14**. Thus the position of lead panel **14** limits the extent to which lag panel **16** can move to the right. As drive unit **32** moves lead panel **14** to the right, the tension in cable **56** exerts an acceleration force **164** that urges lag panel **16** to move with lead panel **14**. Panels **14** and **16** move through their positions shown in FIG. **5** and come to rest as shown in FIG. **6**, where door **12** is fully open. Since lag panel **16** is moved toward the open position by auxiliary drive **52**, movement of panel **16** is not dependent on a jarring impact between lead panel **14** and lag panel **16**. Also, the bias toward the open position of lag panel **16** provided by drive mechanism **52** ensures that protrusion **60** is firmly in contact with protrusion **62** on lead panel **14** with the door in the closed position. This accurately maintains the position of lag panel **16**. If the protrusions are seals, this tighter engagement gives better sealing.

Still referring to the right side of the door, to close panels **14** and **16**, drive unit **32** rotates sheave **36** counter-clockwise. This moves belt **34** to pull the right lead panel **14** toward the center of doorway **10**, as shown in FIG. **7**. When lead protrusion **62** engages lag protrusion **60**, lead panel **14** pulls lag panel **16** with it, which in turn lifts weight **54**. Drive unit **32** stops when both panels **14** and **16** reach their closed position, as shown in FIG. **4**.

As for the left-side of door **12**, to smoothly accelerate lag panel **20** to quickly move to its open position in front of wall **30** while the corresponding lead panel **18** opens, drive mechanism **50** selectively couples lag panel **20** to lead panel **18**, such that the panels move independently during part of their travel, and dependently for other parts of travel. In FIG. **8**, for example, drive mechanism **50** includes a flexible ring **64** such as a belt or roller chain encircling two rotatable members **66** such as a sheave, sprocket or some other type of wheel rotatably mounted to lag panel **20**. A link **68** connects lead panel **18** to ring **64**. A bumper **70** is attached to travel with ring **64** such that as the ring moves around wheels **66**, bumper **70** engages a stop **72** that is mounted to wall **30**, or to the track, which is itself mounted to the wall.

As drive unit **32** begins moving the left lead panel **18** from its closed position of FIG. **4** to a partially open position of FIG. **5**, link **68** may flex (depending on its flexibility) as shown. At present, however, a rigid link, such as a section of bar stock is preferred. Through link **68**, lead panel **18** moving relative to lag panel **20** also moves ring **64** around rotating members **66**. The movement of ring **64** moves bumper **70** up against stop **72**, as shown in FIG. **5**. Continued leftward movement of lead panel **18** relative to lag panel **20** causes bumper **70** to push against stop **72**. This creates a reaction or acceleration force **64'** that smoothly moves lag panel **20** to the left at about half the velocity of lead panel **18**. Drive unit **32** stops when both panels **18** and **20** are in their open position, as shown in FIG. **6**.

To close the left side of door **12**, drive unit **32** rotates sheave **36** counter-clockwise. This moves belt **34** to pull the left lead panel **18** toward the center of doorway **10**, as shown in FIG. **7**. The rightward movement of lead panel **18** relative to lag panel **20** causes link **68** to move ring **64** about rotatable members **66**. This, in turn, moves bumper **70** away from stop **72**, as shown in FIG. **7**. A lead panel **18** continues toward the closed position, a protrusion on panel **18** engages a similar protrusion on lag panel **20** (similar to protrusion **62** of panel **14** engaging protrusion **60** of panel **16**), thus pulling lag panel **20** closed. One of skill in the art will appreciate that drive mechanism **50** could also be used to close lag panel **20** by, for example, providing an appropriately-positioned stop such as stop **72**. Other means for moving lag panel **20** to the closed position are also conceivable.

Drive mechanism **50** may thus provide panels **18** and **20** with two states of movement—a first state in which their movement is independent (from FIG. **6** to FIG. **7**, for example); and a second state in which movement of one panel (e.g., panel **20**) is dependent upon movement of another panel (e.g., panel **18**). In this embodiment, panels **18** and **20** move at different speeds when in the second state, by virtue of the mechanics of drive **50**. The current embodiment maintains a constant speed differential (2:1) in the second state.

Although the function of drive mechanism **50** can be provided by a variety of structures, some exemplary

embodiments are shown in FIGS. 9–12. In FIG. 9, for example, ring 64 is a cogged belt 74 (sometimes referred to as a timing belt), rotatable members 66 are cogged sheaves 76 and 78 that mesh with belt 74, and link 68 is a fabric strap 80, although a rigid link may be preferable. A bumper 82 comprises two pieces of bar stock 84 with two bolts 86 that clamp the bars between two cogs 88 of belt 74, as shown in FIG. 10.

To provide stop 72 with vertical and horizontal adjustment as well as vertical clearance to accommodate some vertical movement of belt 74, a stop 90 is configured as shown in FIG. 11. Stop 90 comprises two angled members 92 and 94 with elongated bolt-hole slots 96 and 98 respectively. Slots 96 and 98 provide vertical and horizontal adjustment as bolts 100 extend through them to clamp members 92 and 94 together. A bar 102 is bolted across member 94 with two spacers 104 in between to provide sufficient clearance for belt 74, but being close enough to each other to serve as an effective stop for bumper 82. Spacers 104 are separated from each other to accommodate some vertical movement of belt 74, which may be caused by a lag panel traveling along an inclined track.

Drive mechanism 50 allows adjustability, in that door panels of a given width can be used to serve doorways of different widths. For example, the position of stop 90 can be adjusted. That is, if doorway 10 were narrower, stop 90 could be attached to the wall or track at a location that is further to the right than what is shown in FIG. 9. Then, as the door closes, bumper 82 would abut stop 90 later than it would otherwise. This would thus create more overlap between panels 18 and 20 when the door is closed and provide more travel of the lead panel (relative to the lag panel) toward the open position before drive 50 starts moving the lag panel. Consideration of FIGS. 4–7 is useful in visualizing this effect. The overlap would compensate for the door panels' extra width.

FIG. 12 shows another embodiment that is similar to that of FIGS. 9–11; however, belt 74 is replaced by a roller chain 106, sheaves 76 and 78 are replaced by sprockets 108, and strap 80 is replaced by a rigid link 110. Bumper 82' is nearly the same as bumper 82 used on belt 74, and link 110 is clamped to chain 106 in a manner similar to that of bumpers 82 and 82'. If desired, one or more travel limit stops 112 can be attached to panel 20 to help protect sprockets 108 from being struck by link 110 or bumper 82'.

Although the invention is described with reference to a preferred embodiment, it should be appreciated by those skilled in the art that various modifications are well within the scope of the invention. Therefore, the scope of the invention is to be determined by reference to the claims that follow.

We claim:

1. A door adapted to at least partially cover a doorway in a wall, the door having an opened position and a closed position, comprising:

a first door panel adapted to be mounted for translation in front of the doorway;

a second door panel adapted to be mounted for translation in front of the doorway, wherein the first door panel has a first open position in front of the second door panel, the second door panel has a second open position adjacent the doorway between the first panel and the wall, and the door is in the opened position when the first door panel and the second door panel are in the first open position and the second open position respectively, the first and second door panels each having a closed position relative to the doorway and being arranged to telescope to position the door in the opened or closed position; and

an auxiliary drive mechanism coupling the first door panel and the second door panel such that the first and second door panels have a first state of movement wherein movement of a first one of the first and second door panels is independent of movement of a second one of the first and second door panels, and the first and second door panels have a second state of movement wherein movement of a first one of the first and second door panels is dependent upon movement of a second one of the first and second door panels, wherein upon movement of the first door panel away from its closed position, the auxiliary drive mechanism urges the second door panel to move toward the second open position before the first door panel reaches the first open position; wherein the auxiliary drive mechanism includes a flexible ring encircling two rotatable members coupled to the second door panel.

2. The door of claim 1, further comprising a link that couples the flexible ring to the first door panel.

3. The door of claim 2, wherein the link is pliable.

4. The door of claim 1, further comprising a stop adapted to be coupled at a fixed position relative to the wall to limit an extent to which the flexible ring may move relative to the wall.

5. The door of claim 4, further comprising a bumper attached to the flexible ring and positioned to alternately engage and disengage the stop.

6. The door of claim 1, wherein the flexible ring is a cogged belt and at least one of the two rotatable members is a cogged sheave.

7. The door of claim 1, wherein the flexible ring is a chain and at least one of the two rotatable members is a sprocket.

8. A door adapted to at least partially cover a doorway in a wall, the door having an opened position and a closed position, comprising:

a first door panel adapted to be mounted for translation in front of the doorway;

a second door panel adapted to be mounted for translation in front of the doorway, wherein the first door panel has a first open position in front of the second door panel, the second door panel has a second open position adjacent the doorway between the first panel and the wall, and the door is in the opened position when the first door panel and the second door panel are in the first open position and the second open position respectively, the first and second door panels each having a closed position relative to the doorway and being arranged to telescope to position the door in the opened or closed position;

two rotatable members coupled to the second door panel;

a flexible ring encircling the two rotatable members;

a stop adapted to be coupled to the wall at a fixed position relative to the wall;

a bumper attached to the flexible ring and positioned to alternately disengage and engage the stop to limit an extent to which the flexible ring may move about the two rotatable members; and

a link coupling the flexible ring to the first door panel wherein upon movement of the first door panel away from its closed position, the link, the flexible ring, the two rotatable members, the stop and the bumper cooperate to urge the second door panel to move toward the second open position before the first door panel reaches the first open position.

9. The door of claim 8, wherein the link is pliable.

10. The door of claim 8, wherein the flexible ring is a cogged belt and at least one of the two rotatable members is a cogged sheave.

11. The door of claim 8, wherein the flexible ring is a chain and at least one of the two rotatable members is a sprocket.

12. The door of claim 8, further comprising an opposite door panel substantially coplanar with the first door panel such that the first door panel and the opposite door panel move apart to open the door and move towards each other to close the door, wherein the first door panel abuts the opposite door panel upon closing the door.

13. The door of claim 8, wherein the door has a first opening phase, a second opening phase occurring after the first opening phase when moving the door from the closed to the opened position, a first closing phase and a second closing phase occurring after the first closing phase when moving the door from the opened to the closed position, wherein the first door panel moves independent of the second door panel during both the first opening phase and the first closing phase, and the second door panel is moved by movement of the first door panel during both the second opening phase and the second closing phase.

14. A door adapted to at least partially cover a doorway in a wall, the door having an opened position and a closed position, comprising:

a first door panel adapted to be mounted for translation in front of the doorway;

a second door panel adapted to be mounted for translation in front of the doorway; and

an auxiliary drive mechanism coupling the first door panel and the second door panel, the auxiliary drive mechanism including at least two rotatable members, a flexible ring mounted to the rotatable members for movement thereabout, a stop adapted to be fixed to the wall, and a bumper secured to the ring and positioned to selectively engage the stop to prevent further rotation of the ring in a predefined direction, wherein the first door panel is operatively coupled to the ring such that translation of the first door panel from a closed position toward an open position initially rotates the ring substantially without translating the second door panel and, after engagement of the bumper and stop substantially prevents further rotation of the ring, further translation of the first door panel toward the opened position transfers a translating force through the ring to the second door panel to thereby cause the second door panel to translate toward a closed state.

15. The door of claim 8, wherein the first and second door panels have a first state of movement wherein movement of a first one of the first and second door panels is independent of movement of a second one of the first and second door panels, and wherein the first and second door panels have a second state of movement wherein movement of a first one of the first and second door panels is dependent upon movement of a second one of the first and second door panels.

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